



MODULE HANDBOOK BIOMODELLING



BACHELOR DEGREE PROGRAM
DEPARTMENT OF BIOMEDICAL ENGINEERING
FACULTY OF INTELLIGENT ELECTRICAL AND INFORMATICS
TECHNOLOGY

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

ENDORSEMENT PAGE



MODULE HANDBOOK BIOMODELLING DEPARTMENT OF BIOMEDICAL ENGINEERING INSTITUT TEKNOLOGI SEPULUH NOPEMBER Number : B/21361/IT2.IX.5.1.2/PP.03.00.00/2020

Proses Process	Penanggung Jawab Person in Charge			Tanggal Date
	Nama Name	Jabatan Position	Tandatangan Signature	
Perumus Preparation	Nada Fitriyatul Hikmah, S.T., M.T.	Dosen Lecturer		November 23, 2019
Pemeriksa dan Pengendalian Review and Control	Dr. Achmad Arifin, S.T., M.Eng.	Tim kurikulum Curriculum team		February 12, 2020
Persetujuan Approval	Dr. Rachmad Setiawan, S.T., M.T.	Koordinator RMK Course Cluster Coordinator		March 04, 2020
Penetapan Determination	Dr. Achmad Arifin, S.T., M.Eng.	Kepala Departemen Head of Department		March 11, 2020

MODULE HANDBOOK

BIOMODELLING

Module name	Biomodelling	
Module level	Undergraduate	
Code	EB184506	
Course (if applicable)	Biomodelling	
Semester	First Semester (Gasal)	
Person responsible for the module	Nada F. H., S.T. M.T.	
Lecturer	Dr. Achmad Arifin, S.T., M.Eng. Nada Fitriyatul Hikmah, S.T, M.T. M. Hilman Fatoni, S.T., M.T.	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, mandatory , 5 th semester.	
Type of teaching, contact hours	Lectures, <60 students	
Workload	1. Lectures : 3 x 50 = 150 minutes per week. 2. Exercises and Assignments : 3 x 60 = 180 minutes (3 hours) per week. 3. Private learning : 3 x 60 = 180 minutes (3 hours) per week.	
Credit points	3 credit points (sks)	
Requirements according to the examination regulations	A student must have attended at least 75% of the lectures to sit in the exams.	
Mandatory prerequisites	EB184401 Fundamentals of Signal Processing EB184402 Fundamentals of Control Systems and Laboratory	
Learning outcomes and their corresponding PLOs	Course Learning Outcome (CLO) after completing this module, CLO 1: Students are able to understand the basics of modeling the physiological system of the human body and its limitations. CLO 2: Students are able to apply science concepts to model physiological systems, particularly in the cardiovascular system. CLO 3: Students are able to perform dynamic analysis and modeling for ECG. CLO 4: Students are able to apply the linear prediction method for modeling sound signals.	PLO-02 PLO-02 PLO-02 PLO-02

	CLO 5: Students understand the concept of a 3D coordinate system and its use in deriving the motion equation. CLO 6: Students are able to realize 3D programming for the application of modeling the human body physiology system. CLO 7: Students are able to understand muscular modeling in biomechanical computation.	PLO-09 PLO-09 PLO-06
Content	The Biomodeling course is a compulsory subject required to learn about the technique of modeling the human body physiology system based on the characteristics of the physiological system. This course aims to enable students to understand biological functions and apply scientific concepts to model physiological systems. Based on this understanding and analytical skills, students can also use it in the biomedical engineering discipline.	
Study and examination requirements and forms of examination	• In-class exercises • Assignment 1, 2, 3 • Mid-term examination • Final examination	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom.	
Reading list	1. Marmarelis, V.Z., 2004, "Nonlinear Dynamic Modeling of Physiological System", John Wiley & Sons, Inc. 2. Rideout, V.C., 1991, "Mathematical and Computer Modeling of Physiological Systems", Prentice-Hall Inc. 3. Vaseghi, S.V., 2008, "Advanced Digital Signal Processing and Noise Reduction, Fourth Edition", John Wiley & Sons, Inc. 4. McSharry, P.E., Clifford, G.D., Tarassenko, L., and Smith, L.A., 2003, "A Dynamical Model for Generating Synthetic Electrocardiogram Signals", <i>IEEE Transaction on Biomedical Engineering</i>, Vol. 50, No. 3, pp. 289-294.	

I. Rencana Pembelajaran Semester / Semester Learning Plan

	INSTITUT TEKNOLOGI SEPULUH NOPEMBER (ITS) FAKULTAS TEKNOLOGI ELEKTRO DAN INFORMATIKA CERDAS DEPARTEMEN TEKNIK BIOMEDIK					Kode Dokumen
RENCANA PEMBELAJARAN SEMESTER						
MATA KULIAH (MK) COURSE	KODE CODE	Rumpun MK Course Cluster	BOBOT (sks) CREDITS		SEMESTER	Tgl Penyusunan Compilation Date
Biomodeling	EB184506	Biocybernetics	T=3	P=0	V	June 27, 2020
OTORISASI / PENGESAHAN AUTHORIZATION / ENDORSEMENT	Dosen Pengembang RPS Developer Lecturer of Semester Learning Plan		Koordinator RMK Course Cluster Coordinator		Ka DEPARTEMEN Head of Department	
	(Nada F. H., S.T. M.T.)		(Ir. Josaphat Pramudijanto, M.Eng.)		(Dr. Achmad Arifin, S.T., M.Eng.)	
Capaian Pembelajaran Learning Outcomes	CPL-PRODI yang dibebankan pada MK PLO Program Charged to The Course					
	CPL-02 PLO-02	Mampu menemukan, memahami, menjelaskan, merumuskan, dan menyelesaikan permasalahan umum pada bidang Teknik dan permasalahan khusus pada bidang Teknik Biomedika yang meliputi instrumentasi biomedika cerdas, teknik rehabilitasi medika, pencitraan dan pengolahan citra medika, serta informatika medika. Able to find, understand, explain, formulate, and solve general problems in the field of Engineering and special problems in the field of Biomedical Engineering which includes intelligent biomedical instrumentation, medical rehabilitation techniques, imaging and processing of medical images, and medical informatics				
	CPL-06 PLO-06	Mampu menerapkan ilmu pengetahuan, keterampilan, dan metode terkini dalam menyelesaikan permasalahan di bidang Teknik Biomedika. Able to apply the latest knowledge, skills and methods in solving problems in the field of Biomedical Engineering				
	CPL-09	Mampu mengetahui/mengikuti perkembangan terkini dibidang ilmu pengetahuan dan teknologi serta menyikapinya secara obyektif				

	PLO-09 dengan mengedepankan nilai-nilai kebenaran universal. <i>Able to know/follow the latest developments in the field of science and technology and to react objectively by promoting the values of universal truth</i>
	Capaian Pembelajaran Mata Kuliah (CPMK) – Bila CP MK sebagai kemampuan pada tiap tahap pembelajaran CP MK = Sub CP MK Course Learning Outcome (CLO) - If CLO as description capability of each Learning Stage in the course, then CLO = LLO
CP MK 1 CLO 1	Mahasiswa mampu memahami dasar pemodelan sistem fisiologi tubuh manusia dan limitasinya. <i>Students are able to understand the basics of modeling the physiological system of the human body and its limitations.</i>
CP MK 2 CLO 2	Mahasiswa mampu menerapkan konsep sains untuk memodelkan sistem fisiologi, terutama pada sistem kardiovaskular. <i>Students are able to apply science concepts to model physiological systems, particularly in the cardiovascular system.</i>
CP MK 3 CLO 3	Mahasiswa mampu melakukan analisis dan pemodelan dinamis untuk ECG. <i>Students are able to perform dynamic analysis and modeling for ECG.</i>
CP MK 4 CLO 4	Mahasiswa mampu menerapkan metode linier prediction untuk pemodelan sinyal suara. <i>Students are able to apply the linear prediction method for modeling sound signals.</i>
CP MK 5 CLO 5	Mahasiswa memahami konsep sistem koordinat 3D dan penggunaannya dalam menurunkan motion equation. <i>Students understand the concept of a 3D coordinate system and its use in deriving the motion equation.</i>
CP MK 6 CLO 6	Mahasiswa mampu merealisasikan pemrograman 3D untuk aplikasi pemodelan sistem fisiologi tubuh manusia. <i>Students are able to realize 3D programming for the application of modeling the human body physiology system.</i>
CP MK 7 CLO 7	Mahasiswa mampu memahami pemodelan muscular dalam komputasi biomekanika. <i>Students are able to understand muscular modeling in biomechanical computation.</i>

Peta CPL – CP MK Map of PLO - CLO		CPL-01	CPL-02	CPL-03	CPL-04	CPL-05	CPL-06	CPL-07	CPL-08	CPL-09	CPL-10	CPL-11	CPL-12
	CPMK 1 / SUB CPMK 1 <i>CLO 1 / LLO 1</i>		√										
	CPMK 2 / SUB CPMK 2 <i>CLO 2 / LLO 2</i>		√										
	CPMK 3 / SUB CPMK 3 <i>CLO 3 / LLO 3</i>		√										
	CPMK 4 / SUB CPMK 4 <i>CLO 4 / LLO 4</i>		√										
	CPMK 5 / SUB CPMK 5 <i>CLO 5 / LLO 5</i>									√			
	CPMK 6 / SUB CPMK 6 <i>CLO 6 / LLO 6</i>									√			
	CPMK 7 / SUB CPMK 7 <i>CLO 7 / LLO 7</i>						√						
Diskripsi Singkat MK Short Description of Course	Mata kuliah Biomodeling merupakan mata kuliah wajib yang diperlukan untuk mempelajari mengenai teknik pemodelan sistem fisiologi tubuh manusia berdasarkan karakteristik dari sistem fisiologi tersebut. Mata kuliah ini bertujuan agar mahasiswa mampu memahami fungsi biologi dan menerapkan konsep sains untuk memodelkan sistem fisiologi. Berdasarkan pemahaman dan kemampuan analisis tersebut, mahasiswa juga dapat memanfaatkannya dalam disiplin ilmu teknik biomedik. <i>The Biomodeling course is a compulsory subject required to learn about the technique of modeling the human body physiology system based on the characteristics of the physiological system. This course aims to enable students to understand biological functions and apply scientific concepts to model physiological systems. Based on this understanding and analytical skills, students can also use it in the biomedical engineering discipline.</i>												
Bahan Kajian: Materi pembelajaran Course Materials:	1. Konsep Biomodelling / <i>Biomodelling Concept</i> 2. Pemodelan sistem kardiovaskular / <i>Cardiovascular system modeling</i> 3. Model dinamis untuk ECG / <i>Dynamic model for ECG</i> 4. Linear Prediction Coding / <i>Linear Prediction Coding</i> 5. 3D Programming / <i>3D Programming</i> 6. Pemodelan sistem gerak / <i>Modeling of motion systems</i> 7. Pemodelan otot / <i>Muscle modeling</i>												

Pustaka References	Utama / Main :
	1. Marmarelis, V.Z., 2004, "Nonlinear Dynamic Modeling of Physiological System", John Wiley & Sons, Inc. 2. Rideout, V.C., 1991, "Mathematical and Computer Modeling of Physiological Systems", Prentice-Hall Inc.
	Pendukung / Supporting:
	3. Vaseghi, S.V., 2008, "Advanced Digital Signal Processing and Noise Reduction, Fourth Edition", John Wiley & Sons, Inc. 4. McSharry, P.E., Clifford, G.D., Tarassenko, L., and Smith, L.A., 2003, "A Dynamical Model for Generating Synthetic Electrocardiogram Signals", <i>IEEE Transaction on Biomedical Engineering</i> , Vol. 50, No. 3, pp. 289-294.
Dosen Pengampu Lecturers	Dr. Achmad Arifin, S.T. M.Eng., Nada Fitriyatul Hikmah S.T, M.T., M. Hilman Fatoni, S.T., M.T.
Mata kuliah syarat Prerequisite	EB184401 Dasar Pengolahan Sinyal EB184402 Dasar Sistem Pengaturan dan Laboratorium <i>EB184401 Fundamentals of Signal Processing</i> <i>EB184402 Fundamentals of Control Systems and Laboratory</i>

Mg Ke/ Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final ability of each learning stage (LLO)</i>	Penilaian / Assessment		Bentuk Pembelajaran; Metode Pembelajaran; Penugasan Mahasiswa; <i>[Estimasi Waktu] / Form of Learning; Learning Method; Student Assignment; [Estimated Time]</i>		Materi Pembelajaran <i>[Pustaka] / Learning Material [Reference]</i>	Bobot Penilaian (%) / Assessment Load (%)
		Indikator / Indicator	Kriteria & Teknik / Criteria & Techniques	Tatap Muka (5) / In-class (5)	Daring (6) / Online (6)	(7)	(8)
1	Mahasiswa mampu memahami dasar pemodelan sistem fisiologi tubuh manusia dan limitasinya. <i>Students are able to understand the basics of modeling the physiological system of the human body and its limitations.</i>	- Mampu mendefinisikan tujuan dan desain dari pemodelan secara umum - Mampu menjelaskan tantangan membuat model ideal pada sistem fisiologi - Mampu membuat blok pemodelan berdasarkan model specification <i>Able to define the objectives and design of modeling in general</i> <i>Able to explain the challenges of making ideal models of physiological systems</i> <i>Able to make modeling</i>	Diskusi dan tanya jawab. Test: Soal ETS (masuk dalam penilaian ETS) <i>Discussion and questions and answers.</i> Test: <i>Mid-term examination questions (included in the mid-term assessment)</i>	- Kuliah dan brainstorming, tanya jawab [TM : 1x3x50"] [BM : 1x3x60"] [PT : 1x3x60"] <i>Presentation and brainstorming, question and answer.</i> [FF : 1x3x50"] [SA : 1x3x60"] [SS : 1x3x60"]	- Chatting dan diskusi dalam forum platform ITS <i>Chat and discussion in ITS platform forum.</i>	- Kontrak kuliah: - Motivasi belajar - Rencana pembelajaran - Aturan-aturan perkuliahan - Tujuan perkuliahan - Sistem penilaian, buku ajar/sumber pustaka - Modeling process - Model design - Physiology modelling - Model specification - Model estimation <i>Course contract:</i> - Motivation to	

		<i>blocks based on specification models</i>				<i>learn</i> - Lesson plan - Lecture rules - Course objective - Assessment system, textbooks / library resources • Modeling process • Model design • Physiology modelling • Model specification • Model estimation	
2	Mahasiswa mampu menerapkan konsep sains untuk memodelkan sistem fisiologi, terutama pada sistem kardiovaskular. <i>Students are able to apply science concepts to model physiological systems, particularly in the cardiovascular system.</i>	• Mampu membedakan pemodelan white box, black box, dan grey box. • Mampu memahami perkembangan konsep pemodelan pada pembuluh darah dari 0D hingga 3D. • Mampu melakukan pemodelan pembuluh darah dengan analogi rangkaian listrik. • <i>Able to distinguish between white box, black box and gray box</i>	Non-tes: Tugas 1 tahap 1: Melakukan pemodelan sistem pembuluh darah dengan analogi rangkaian listrik Tes: Soal ETS (masuk dalam penilaian ETS) Non-test: Task 1 stage 1: Perform modeling of the vascular	• Kuliah, diskusi, tanya jawab, tugas [TM : 1x3x50"] [BM : 1x3x60"] [PT : 1x3x60"] • Lecture, discussion, question and answer, exercise and assignment [FF : 1x3x50"] [SA : 1x3x60"]		• <i>White, black, grey box</i> • <i>Lumped parameter</i> • <i>Distributed parameter</i> • <i>Mapping cardiovascular element to electrical element</i> • <i>Windkessel model</i>	2.5

		<i>modeling.</i> • <i>Able to understand the development of modeling concepts in blood vessels from 0D to 3D.</i> • <i>Able to perform blood vessel modeling by analogy to electrical circuits.</i>	<i>system using an electrical circuit analogy</i> Test: Mid-term examination questions (included in the mid-term assessment)	[SS : 1x3x60"]			
3 - 4	Mahasiswa mampu melakukan analisis dan pemodelan dinamis untuk ECG. <i>Students are able to perform dynamic analysis and modeling for ECG.</i>	• Mampu menjelaskan proses fisiologi dari morfologi gelombang pada sinyal ECG. • Mampu mendefinisikan fungsi parameter yang berkaitan dengan pemodelan. • Mampu menjelaskan dan mengaplikasikan algoritma untuk pemodelan dinamis ECG. • <i>Able to explain the physiological processes of wave morphology in ECG signals.</i> • <i>Able to define</i>	Non-tes : Tugas 1 tahap 2: Melakukan komputasi dan analisis terhadap model dinamis sinyal ECG Tes : Soal ETS (masuk dalam penilaian ETS) Non-test: Task 1 stage 2: Perform computation and analysis of the dynamic model of the ECG signal		• Kuliah, diskusi, tanya jawab, tugas dalam platform myITS Classroom [TM : 2x3x50"] [BM : 2x3x60"] [PT : 2x3x60"] • <i>Lecture, discussion, question and answer, exercise and assignment</i> [FF : 2x3x50"] [SA : 2x3x60"] [SS : 2x3x60"]	• Fisiologi morfologi ECG • Karakteristik spectral • Morphological parameter • State space • <i>Physiology of ECG morphology</i> • <i>Spectral characteristics</i> • <i>Morphological parameters</i> • <i>State space</i>	5

		<i>parameter functions related to modeling.</i> • Able to explain and apply algorithms for dynamic ECG modeling.	Test: Mid-term examination questions (included in the mid-term assessment)				
5-7	Mahasiswa mampu menerapkan metode linier prediction untuk pemodelan sinyal suara. <i>Students are able to apply the linear prediction method for modeling sound signals.</i>	• Mampu mengaplikasikan trajectory prediction untuk memodelkan spektrum dari sinyal. • Mampu melakukan komputasi untuk mengambil data sinyal suara. • Mampu memodelkan sinyal suara dengan metode linier prediction • Able to apply trajectory prediction to model the spectrum of signals. • Able to perform computations to retrieve voice signal data. • Able to model voice signal using linear prediction method	Non-tes: Tugas 2: Melakukan komputasi linear prediction model dengan masukan sinyal suara. Tes: Soal ETS (masuk dalam penilaian ETS) Non-test: Task 2: Computing the linear prediction model with voice signal input. Test: Mid-term examination questions (included in the mid-term	• Kuliah, diskusi, tanya jawab, tugas [TM : 3x3x50"] [BM : 3x3x60"] [PT : 3x3x60"] • Lecture, discussion, question and answer, exercise and assignment [FF : 3x3x50"] [SA : 3x3x60"] [SS : 3x3x60"]		• Linier prediction coding • Predictor coefficient • Restorasi sinyal domain frekuensi • Linear prediction coding • Predictor coefficient • Frequency domain signal restoration	7.5

			assessment)				
8	EVALUASI TENGAH SEMESTER MID-SEMESTER EXAM						35
9	Mahasiswa memahami konsep sistem koordinat 3D dan penggunaannya dalam menurunkan motion equation. <i>Students understand the concept of a 3D coordinate system and its use in deriving the motion equation.</i>	• Mampu memahami konsep sistem koordinat 3D. • Mampu menggunakan sistem koordinat 3D dalam menurunkan persamaan gerak. • Mampu menggunakan OpenGL untuk pemrograman 3D. • <i>Able to understand the concept of the 3D coordinate system.</i> • <i>Able to use a 3D coordinate system in deriving equations of motion.</i> • <i>Able to use OpenGL for 3D programming.</i>	Tes : Soal EAS (masuk dalam penilaian ETS) Test: <i>Final examination questions (included in the mid-term assessment)</i>	• Kuliah, diskusi, tanya jawab, tugas [TM : 1x3x50"] [BM : 1x3x60"] [PT : 1x3x60"] • <i>Lecture, discussion, question and answer, exercise and assignment</i> [FF : 1x3x50"] [SA : 1x3x60"] [SS : 1x3x60"]		• <i>Numerical Integration</i> • <i>Motion Equation</i> • <i>Coordynate system to motion equation</i>	
10 -12	Mahasiswa mampu merealisasikan pemrograman 3D untuk aplikasi pemodelan sistem fisiologi tubuh manusia. <i>Students are able to realize 3D</i>	• Mampu merealisasikan 3D programming dengan memanfaatkan OpenGL • Mampu mengaplikasikan Human Machine	Non-tes : Tugas 3 tahap 1: Melakukan komputasi dan analisis sesuai tugas human movement model yang diarahkan	• Kuliah, diskusi, tanya jawab, tugas [TM : 3x3x50"] [BM : 3x3x60"] [PT : 3x3x60"]		• <i>OpenGL</i> • <i>3D programming</i> • <i>Human Machine Interaction</i> • <i>Human movement model</i>	10

	<i>programming for the application of modeling the human body physiology system.</i>	Interaction pada pemodelan untuk 3D programming • <i>Able to realize 3D programming by using OpenGL</i> • <i>Able to apply Human Machine Interaction in modeling for 3D programming</i>	untuk pemodelan fisiologi tubuh manusia. Tes : Soal EAS (masuk dalam penilaian EAS) Non-test: Task 3 stage 1: <i>Perform computation and analysis according to the task of the human movement model which is directed at modeling the physiology of the human body.</i> Test: <i>Final examination questions (included in the mid-term assessment)</i>	• <i>Lecture, discussion, question and answer, exercise and assignment</i> <i>[FF : 3x3x50"]</i> <i>[SA : 3x3x60"]</i> <i>[SS : 3x3x60"]</i>			
13-14	Mahasiswa mampu memahami pemodelan muscular dalam komputasi biomekanika.	• Mampu memahami muscle modeling berdasarkan Hill Type Muscle model.	Non-tes : Tugas 3 tahap 2: Menyusun program simulasi untuk	• Kuliah, diskusi, tanya jawab, tugas		• <i>Muscle mechanics effect of stretch and shortening on skeletal force</i>	10

	<i>Students are able to understand muscular modeling in biomechanical computation.</i>	• Mampu merealisasikan Hill Muscle model dalam komputasi biomekanika • <i>Able to understand muscle modeling based on Hill Type Muscle model.</i> • <i>Able to realize Hill Muscle model in biomechanical computation</i>	muscle force Tes : Soal EAS (masuk dalam penilaian EAS) Non-test: Task 3 stage 2: <i>Develop a simulation program for muscle force</i> Test: <i>Final examination questions (included in the mid-term assessment)</i>	[TM : 2x3x50"] [BM : 2x3x60"] [PT : 2x3x60"] • <i>Lecture, discussion, question and answer, exercise and assignment</i> [FF : 2x3x50"] [SA : 2x3x60"] [SS : 2x3x60"]		• <i>Fisiologi otot</i> • <i>Muscle modelling</i> • <i>Hill type muscle model</i>	
15-16	EVALUASI AKHIR SEMESTER FINAL-SEMESTER EXAM						30

TM=Tatap Muka, **PT**=Penugasan Terstruktur, **BM**=Belajar Mandiri.

II. Rencana Asesmen & Evaluasi (RAE) / *Assessment & Evaluation Plan*

	ASSESSMENT & EVALUATION PLAN BACHELOR DEGREE PROGRAM OF BIOMEDICAL ENGINEERING - FTEIC ITS Course : Biomodelling			RA&E
				Write Doc Code
Kode / Code: EB184506	Bobot sks / Credits (T/P): 3/0	Rumpun MK: Biocybernetics Course Cluster: Biocybernetics	Smt: 5	
OTORISASI AUTHORIZATION	Penyusun RA & E <i>Compiler A&EP</i> Nada F. H., S.T. M.T.	Koordinator RMK <i>Course Cluster Coordinator</i> Ir. Josaphat Pramudijanto, M.Eng.	Ka DEP <i>Head of DEP</i> Dr. Achmad Arifin, S.T., M.Eng.	

Mg ke / Week (1)	Sub CP-MK / <i>Lesson Learning Outcomes (LLO)</i> (2)	Bentuk Asesmen (Penilaian) <i>Form of Assessment</i> (3)	Bobot / <i>Load (%)</i> (4)
1	Sub CP-MK 1: Mahasiswa mampu memahami dasar pemodelan sistem fisiologi tubuh manusia dan limitasinya. LLO 1: <i>Students are able to understand the basics of modeling the human body physiology system and its limitations.</i>	Tes : ETS Soal 1 (3% dari ETS 35%) Test: <i>Mid-term examination question 1 (3% of 35% ETS)</i>	
2	Sub CP-MK 2: Mahasiswa mampu menerapkan konsep sains untuk memodelkan sistem fisiologi, terutama pada sistem kardiovaskular. LLO 2: <i>Students are able to apply science concepts to model</i>	Non-tes: Tugas 1 tahap 1: Melakukan pemodelan sistem pembuluh darah dengan analogi rangkaian listrik Tes: ETS Soal 2 (7% dari ETS 35%) Non-test: Task 1 stage 1: <i>Perform modeling of the vascular system using an electrical circuit analogy</i> Test:	2.5

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<i>physiological systems, particularly in the cardiovascular system.</i>	<i>Mid-term examination question 2 (7% of 35% ETS)</i>	
3	Sub CP-MK 3: Mahasiswa mampu melakukan analisis dan pemodelan dinamis untuk ECG. LLO 3: <i>Students are able to perform dynamic analysis and modeling for ECG.</i>	Non-tes : Tugas 1 tahap 2: Melakukan komputasi dan analisis terhadap model dinamis sinyal ECG Tes: ETS Soal 3 (10% dari ETS 35%) Non-test: Task 1 stage 2: <i>Perform computation and analysis of the dynamic model of the ECG signal</i> Test: <i>Mid-term examination question 3 (10% of 35% ETS)</i>	5
6	Sub CP-MK 4: Mahasiswa mampu menerapkan metode linier prediction untuk pemodelan sinyal suara. LLO 4: <i>Students are able to apply the linear prediction method for modeling sound signals.</i>	Non-tes: Tugas 2: Melakukan komputasi linear prediction model dengan masukan sinyal suara. Tes: ETS Soal 4 (15% dari ETS 35%) Non-test: Task 2: <i>Computing the linear prediction model with voice signal input</i> Test: <i>Mid-term examination question 4 (15% of 35% ETS)</i>	7.5
8	Evaluasi Tengah Semester Mid-Term Exam	Tes: Ujian Tulis/Ujian Daring Test: <i>Written Exams/Online Examinations</i>	35
9	Sub CP-MK 5: Mahasiswa memahami konsep sistem koordinat 3D dan penggunaannya dalam menurunkan motion equation.	Tes : EAS Soal 1 (10% dari EAS 30%) Test: <i>Final examination question 1 (10% of 30% EAS)</i>	

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	LLO 5: <i>Students understand the concept of a 3D coordinate system and its use in deriving the motion equation.</i>		
11	Sub CP-MK 6: Mahasiswa mampu merealisasikan pemrograman 3D untuk aplikasi pemodelan sistem fisiologi tubuh manusia. LLO 6: <i>Students are able to realize 3D programming for the application of modeling the human body physiology system.</i>	Non-tes: Tugas 3 tahap 1: Melakukan komputasi dan analisis sesuai tugas human movement model yang diarahkan untuk pemodelan fisiologi tubuh manusia. Tes: EAS Soal 2 (10% dari EAS 30%) Non-test: Task 3 stage 1: <i>Perform computation and analysis according to the task of the human movement model which is directed at modeling the physiology of the human body.</i> Test: <i>Final examination question 2 (10% of 30% EAS)</i>	10
13	Sub CP-MK 7: Mahasiswa mampu memahami pemodelan muscular dalam komputasi biomekanika. LLO 7: <i>Students are able to understand muscular modeling in biomechanical computation.</i>	Non-tes: Tugas 3 tahap 2: Menyusun program simulasi untuk muscle force Tes: EAS Soal 3 (10% dari EAS 30%) Non-test: Task 3 stage 2: <i>Develop a simulation program for muscle force</i> Test: <i>Final examination question 3 (10% of 30% EAS)</i>	10
16	Evaluasi Akhir Semester	Tes: Ujian Tulis/Ujian Daring	30

Mg ke / Week (1)	Sub CP-MK / Lesson Learning Outcomes (LLO) (2)	Bentuk Asesmen (Penilaian) Form of Assessment (3)	Bobot / Load (%) (4)
	<i>Final Exam</i>	Test: <i>Written Exams/Online Examinations</i>	
Total bobot penilaian Total assessment load			100%

Indikator Pencapaian CPL Pada MK / *Indicator of PLO achievement charged to the course*

CPL yang dibebankan pada MK / <i>PLO charged to the course</i>	CPMK / <i>Course Learning Outcome (CLO)</i>	Minggu ke / <i>Week</i>	Bentuk Asesmen / <i>Form of Assessment</i>	Bobot / <i>Load (%)</i>
CPL-02 / PLO-02	CPMK 1 / CLO 1	Week- 8	Mid Exam Question 1	3
	CPMK 2 / CLO 2	Week- 2	Task 1 stage	2.5
		Week- 8	Mid Exam Question 2	7
	CPMK 3 / CLO 3	Week- 3	Task 1 stage 2	5
		Week- 8	Mid Exam Question 3	10
	CPMK 4 / CLO 4	Week- 6	Task 2	7.5
		Week- 8	Mid Exam Question 4	15
CPL-06 / PLO-06	CPMK 7 / CLO 7	Week- 13	Task 3 stage 2	10
		Week- 16	Final Exam Question 3	10
CPL-09 / PLO-09	CPMK 5 / CLO 5	Week- 16	Final Exam Question 1	10
	CPMK 6 / CLO 6	Week- 11	Task 3 stage 1	10
		Week- 16	Final Exam Question 2	10
				Σ = 100%

No	Form of Assessment	PLO-01	PLO-02	PLO-03	PLO-04	PLO-05	PLO-06	PLO-07	PLO-08	PLO-09	PLO-10	PLO-11	PLO-12	Total
1	Task 1		0.075											0.075
2	Task 2		0.075											0.075
3	Mid Exam		0.350											0.350
4	Task 3						0.100			0.100				0.200
5	Final Exam						0.100			0.200				0.300
	Total		0.5				0.2			0.3				1